

Preliminary Storm Water Report

For

6400 Arapahoe

6400 Arapahoe
Boulder, Colorado

18 March 2011

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Job Number: 20024-00BLCV

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review)\20024DRN-P.doc)

Preliminary Storm Water Report
6400 Arapahoe
6400 Arapahoe Ave.
Boulder, CO

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1.0 INTRODUCTION

This report is prepared in accordance with the City of Boulder "Design and Construction Standards", Section 7.03 Preliminary Storm Water Report and Plan and is required as part of the 6400 Arapahoe Site Review Application.

The proposed 6400 Arapahoe project is a proposed 9.7+/-acre re-development and sub-division generally located on the south side of Arapahoe Avenue, east of 63rd Street. An existing commercial building, warehouses and storage buildings along with parking currently occupies the site. A vicinity map is provided in Appendix A. The site drainage generally sheet flows from south to north with a number of existing inlets and storm pipes directing flows to the ditch along the south side of Arapahoe Avenue. The legal description for the property is:

That portion of the northwest ¼ of the northwest ¼ of Section 35, Township 1 North, Range 70 West of the 6th P.M.; described as follows: Beginning at a point on the north line of Section 35, Township 1 North, Range 70 West of the 6th P.M.; whence the northwest corner of said section of 35 bears north 89°49' west, 458.00 feet; thence south 637.00 feet; thence south 81°37' east, 644.67 feet; thence north 728.95 feet to the north line of said section 35; thence along the north line of said section 35, north 89°49' west, 637.78 feet to the point of beginning, County of Boulder, State of Colorado.

Per FEMA map number 08013CO415F dated June 2, 1995, the site is not located within a regulatory floodplain.

2.0 PROPOSED DEVELOPMENT

The proposed re-development of the site will be phased. This report will address full build-out as shown on the phase II drawings of the Site Review submittal package. The proposed pond shall be constructed as part of phase I, but shall be sized for full build-out of the project, including an assumed 90% imperviousness for the "phase III development area." All existing major structures on the site are proposed to remain. Two new warehouses, a new covered storage area and an expanded showroom and warehouse are proposed. The majority of storm runoff from the site will be collected via

sheet flow and curb and gutter and inlets and directed to the proposed pond. Runoff from the western and northwestern portion of the site cannot feasibly be directed to the pond and will continue to free release to the ditch on the south side of Arapahoe Avenue. The pond shall release runoff to a storm sewer stub proposed as part of the Arapahoe Avenue improvement project by CDOT. See the basin descriptions in section 3.2 for additional detail.

3.0 HYDROLOGY

The Rational Method as outlined in Section 7.05D of the City of Boulder "Design and Construction Standards" was used to determine the rainfall and runoff conditions for the existing and proposed development of the site. The runoff rates for minor and major design storm events were calculated. The resulting runoff rates are summarized below in Table 3.1.

Table 3.1: Hydrology Summaries

Basin	Runoff Rates (CFS)	
	10-YR	100-YR
A-HISTORIC	27.32	44.79
B-HISTORIC	7.34	13.85
Site-HISTORIC	34.66	58.64
A-PROPOSED	33.00	51.23
Pond-PROPOSED	26.60 (max)	44.61 (max)
B-PROPOSED	8.06	14.03
Site-PROPOSED	34.66 (max)	58.64 (max)

The supporting calculations for the runoff rates presented above are provided in Appendix C of this report. The Preliminary Grading & Storm Water Plans provided in the back pocket of this report shows the tributary basin delineation for the design points.

Detailed onsite drainage design, including sizing of facilities, will be provided during the Technical Document Review phase.

3.1 EXISTING HYDROLOGICAL CONDITIONS

Drainage calculations were made two basins on the current and historic site. Very little to no offsite runoff appears to enter the property and total site discharges are summarized below.

Design Point A

Basin A covers the majority of the site including the south, east and central portions. The basin is 7.10 acres, is currently 70.35% impervious and is developed with buildings and large amounts of paved area. Runoff from the basin is conveyed to the swale along Arapahoe road via sheet flow, inlets and private storm sewer. Design Point A is located at the connection to the proposed storm sewer by CDOT on the north side of the site near the entrance drive.

Design Point B

Basin B covers the remainder of the site including the western and northern pieces. The basin is 1.85 acres, is currently 55.15% impervious and is developed with buildings and parking area. Runoff from the basin is conveyed to the swale along Arapahoe road via sheet flow, curb and gutter and a swale along the western edge of the property. Design Point B is located at the connection to the proposed storm sewer by CDOT at the northwest corner of the site.

The existing run-off rate for the site is presented in Table 3.1. The site currently does not provide any formal water quality control or detention of onsite runoff. No major drainage problems are evident on the site. The proposed improvements of Arapahoe Road by DCOT include storm sewer that was sized for the existing site conditions. Currently there are no apparent offsite flows entering the site that need to be accounted for in the design process.

3.2 PROPOSED HYDROLOGICAL CONDITIONS

The proposed site redevelopment generally maintains the existing drainage patterns. The Phase II Preliminary Grading & Storm Water Plan in the back pocket shows the proposed drainage basins and Design Points.

Design Point A

Basin A covers the majority of the site including the south, east and central portions. The basin is 7.10 acres, is proposed to be 83.05% impervious and is developed with buildings and large amounts of paved area. Basin A contains Lot 2, which is anticipated for future development. Lot 2 has been assumed to be 90% impervious for runoff and detention calculations. Runoff from the basin is conveyed to pond via sheet flow, inlets and private storm sewer. Design Point A is located at the pond outfall connection to the proposed storm sewer by CDOT on the north side of the site near the entrance drive.

Design Point B

Basin B covers the remainder of the site including the western and northern pieces. The basin is 1.85 acres, is proposed to be 56.53% impervious and is developed with buildings and parking area. Runoff from the basin is conveyed to the proposed CDOT storm sewer via sheet flow and a swale along the western edge of the property. Design Point B is located at the connection to the proposed storm sewer by CDOT at the northwest corner of the site.

The proposed run-off rates from the site are presented in Table 3.1. Supporting calculations are included in Appendix C.

4.0 STORM WATER DETENTION

The storm drainage from the property is currently being released undetained. With the proposed redevelopment of the property, the imperviousness will increase slightly. A detention pond is proposed to detain runoff from Basin A with a volume of approximately 17,000 CF, which will include the water quality capture volume. Runoff from Basin B is can not feasibly be conveyed to the detention pond. Release rates from the detention pond shall be limited to historic runoff from the site, less the un-detained

runoff released from Basin B. Pond outlet sizing shall be included with the final design for the site.

5.0 STORM WATER QUALITY AND EROSION CONTROL

Impacts of the proposed development on downstream properties and drainage facilities will be minimized by the installation and maintenance of erosion and sediment control Best Management Practices (BMPs) during the construction of the proposed improvements. The BMPs will be installed in accordance with City of Boulder "Design and Construction Standards" and Urban Drainage Volume 3. Temporary construction BMPs will include perimeter silt fencing, inlet and outlet protection, check dams, dust mitigation, and revegetation (temporary and permanent).

Permanent erosion control measures will be provided by the proposed extended detention basin. Supporting calculations for initial pond sizing are included in Appendix C. Final pond outlet sizing shall be included with the final design for the site.

6.0 WETLANDS IMPACT

There are currently no known wetland areas on the property. Therefore no wetlands will be impacted by this development.

7.0 CONCLUSION

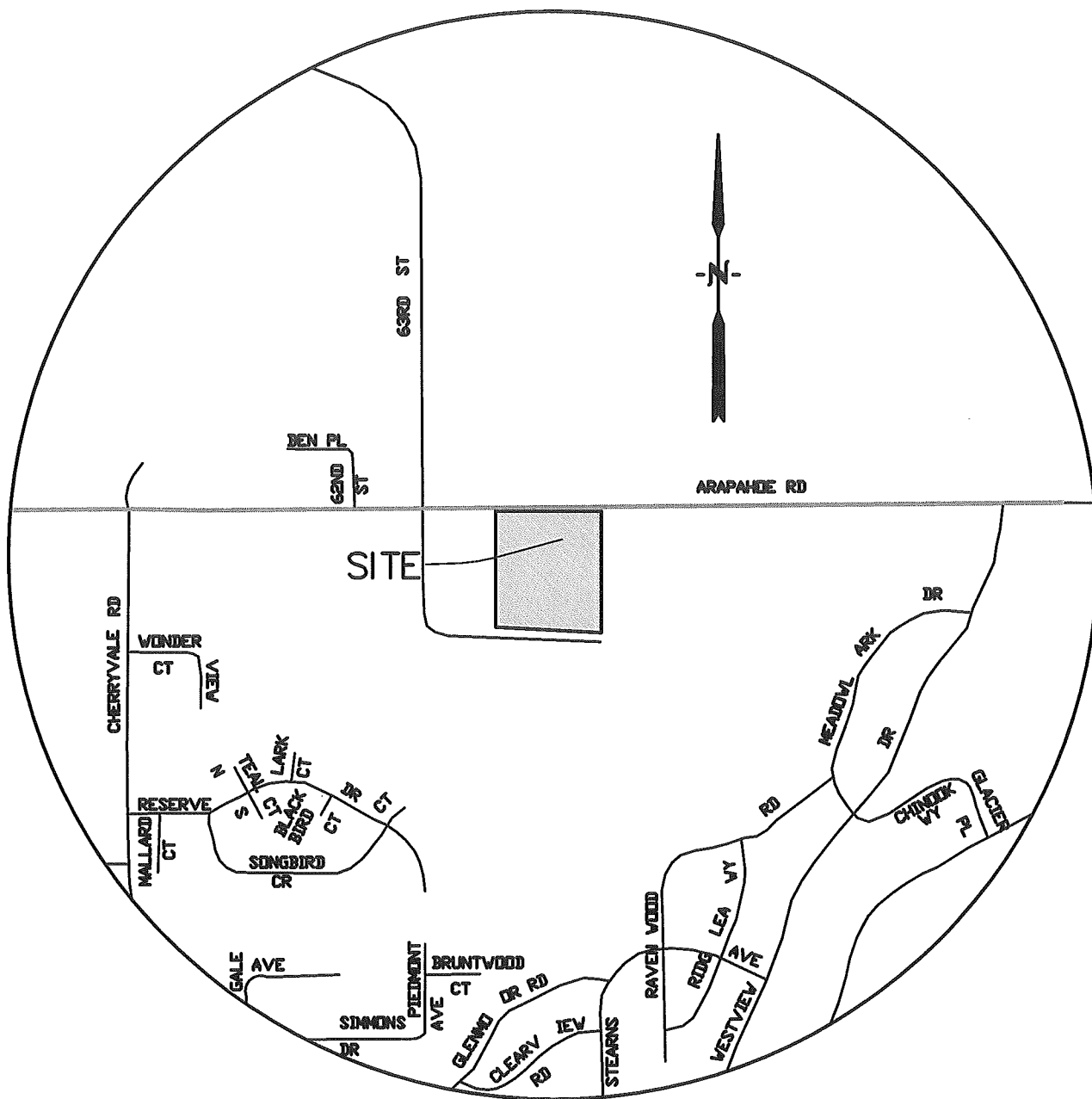
This report discusses the information requirements for a Preliminary Storm Water Report and Plan as defined by the City of Boulder "Design and Construction Standards", Section 7.03. The redevelopment of the property maintains the existing drainage patterns on the site and installation of a detention pond will ensure that the redevelopment will not increase the total runoff release rates from the site. Erosion control BMP's will be implemented during construction in an effort to prevent adverse impacts on downstream properties and drainage facilities. Water quality treatment will be installed to permanently help treat runoff before leaving the site through an

extended detention basin. The proposed development will not adversely affect the surrounding properties or existing storm drainage system.

8.0 REFERENCES

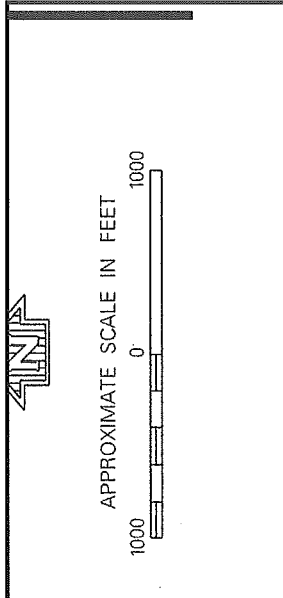
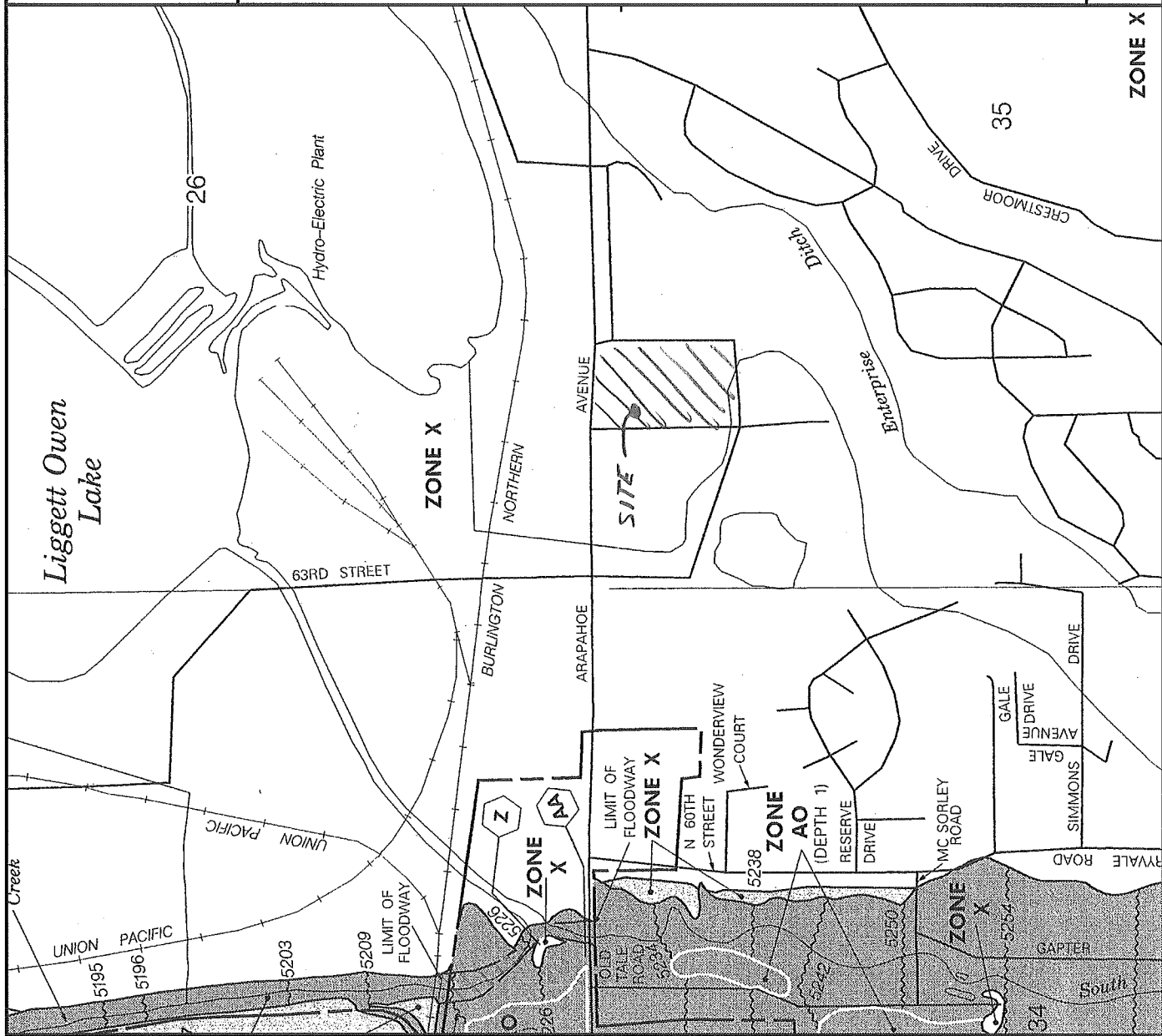
- (1) "Design and Construction Standards" prepared by the City of Boulder, effective 16 November 2000.
- (2) "Urban Storm Drainage Criteria Manual, Volume 3-Best Management Practices" prepared by the Urban Drainage and Flood Control District, effective September 1999.

APPENDIX A: VICINITY MAP



VICINITY MAP
N.T.S.

APPENDIX B: FLOODPLAIN MAP



NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

BOULDER COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 415 OF 595
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
BOULDER COUNTY, UNINCORPORATED AREAS	080023	0415	F	
BOULDER CITY OF	080024	0415	F	

MAP NUMBER 08013C0415 F

EFFECTIVE DATE: JUNE 2, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX C: HYDROLOGY CALCULATIONS



Basin Characteristics

Run-off Analysis

HISTORIC A

Drexel, Barrell & Co.

Project: 6400 Arapahoe
Project No: 20024-00BLCV

Date: 02/15/11
Calculated By: MAA

Tributary Basins:

Description: Main site tributary to detention pond

Soil Type: C

Area [acres] = 7.10

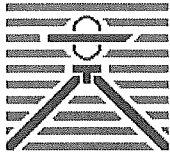
Catchment Composition:

Surface Characteristic ¹	Sub-Area [acres]	I [%]	Runoff Coefficients		
			C ₅	C ₁₀	C ₁₀₀
Streets/Parking Areas: Asphalt	0.00	100	0.88	0.90	0.93
Drives and Walks	4.95	96	0.87	0.90	0.92
Roofs	0.27	90	0.85	0.90	0.90
Lawns	1.88	0	0.20	0.30	0.60

¹ Table RO-3, UDFCD Drainage Criteria Manual V.1

Weighted Percent Imperviousness [%]: I = 70.35

Weighted Runoff Coefficients:
C₅ = 0.69
C₁₀ = 0.74
C₁₀₀ = 0.83



Basin Characteristics

Run-off Analysis

HISTORIC B

Drexel, Barrell & Co.

Project: 6400 Arapahoe
Project No: 20024-00BLCV

Date: 02/15/11
Calculated By: MAA

Tributary Basins:

Description: Remainder of site not tributary to detention pond

Soil Type: C

Area [acres] = 1.85

Catchment Composition:

Surface Characteristic ¹	Sub-Area [acres]	I [%]	Runoff Coefficients		
			C ₅	C ₁₀	C ₁₀₀
Streets/Parking Areas: Asphalt	0.00	100	0.88	0.90	0.93
Drives and Walks	0.65	96	0.87	0.90	0.92
Roofs	0.44	90	0.85	0.90	0.90
Lawns	0.76	0	0.20	0.20	0.60

¹ Table RO-3, UDFCD Drainage Criteria Manual V.1

Weighted Percent Imperviousness [%]: I = 55.14

Weighted Runoff Coefficients:

C ₅	=	0.59
C ₁₀	=	0.61
C ₁₀₀	=	0.78



Basin Characteristics

Run-off Analysis

PROPOSED A

Drexel, Barrell & Co.

Project: 6400 Arapahoe
Project No: 20024-00BLCV

Date: 02/15/11
Calculated By: MAA

Tributary Basins:

Description: Main Site tributary to detention pond

Soil Type: C

Area [acres] = 7.10

Catchment Composition:

Surface Characteristic ¹	Sub-Area [acres]	I [%]	Runoff Coefficients		
			C ₅	C ₁₀	C ₁₀₀
Future Development area	2.15	90	0.80	0.90	0.90
Drives and Walks	3.62	96	0.87	0.90	0.92
Roofs	0.54	90	0.85	0.90	0.90
Lawns	0.79	0	0.20	0.30	0.60

¹ Table RO-3, UDFCD Drainage Criteria Manual V.1

Weighted Percent Imperviousness [%]: I = 83.05

Weighted Runoff Coefficients:
C₅ = 0.77
C₁₀ = 0.83
C₁₀₀ = 0.88



Basin Characteristics

Run-off Analysis

PROPOSED B

Drexel, Barrell & Co.

Project: 6400 Arapahoe
Project No: 20024-00BLCV

Date: 02/15/11
Calculated By: MAA

Tributary Basins:

Description: Remainder of site not tributary to detention pond

Soil Type: C

Area [acres] = 1.85

Catchment Composition:

Surface Characteristic ¹	Sub-Area [acres]	I [%]	Runoff Coefficients		
			C ₅	C ₁₀	C ₁₀₀
Streets/Parking Areas: Asphalt	0.00	100	0.88	0.90	0.93
Drives and Walks	0.48	96	0.87	0.90	0.92
Roofs	0.65	90	0.85	0.90	0.90
Lawns	0.72	0	0.20	0.30	0.60

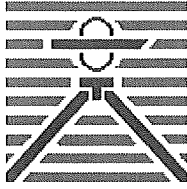
¹ Table RO-3, UDFCD Drainage Criteria Manual V.1

Weighted Percent Imperviousness [%]: I = 56.53

Weighted Runoff Coefficients:
C₅ = 0.60
C₁₀ = 0.67
C₁₀₀ = 0.79

BASIN CHARACTERISTICS	CRITERIA REFERENCE ¹	Basin A Existing	Basin B Existing	Basin A Proposed	Basin B Proposed
IMPERVIOUSNESS, [%]	-	70.35	55.14	83.05	56.53
AREA, A [ACRE]	-	7.10	1.85	7.10	1.85
RUN-OFF COEFFICIENT, C _s	TABLE 7-2	0.69	0.59	0.77	0.60
OVERLAND FLOW LENGTH, L _i [FT]	-	300.00	30.00	300.00	30.00
OVERLAND SLOPE, S _i [%]	-	2.00	2.00	2.00	2.00
OVERLAND FLOW TIME, t _i [MIN]	FIGURE 7-2	10.15	3.99	8.17	3.91
TOTAL TRAVEL FLOW LENGTH, L _t [FT]	-	350.00	525.00	350.00	525.00
TRAVEL SLOPE, S _t [%]	-	2.00	2.00	2.00	2.00
AVERAGE TRAVEL VELOCITY, V _t [FT/SEC]	FIGURE 7-3	3.00	2.50	3.00	2.50
TRAVEL TIME, t _t [MIN]	-	1.94	3.50	1.94	3.50
COMPUTED TIME OF CONCENTRATION, t _c	L/180 + 10	12.09	7.49	10.11	7.41
TIME OF CONCENTRATION, t _c [MIN=5.0]	t _t +t _c	12.09	7.49	10.11	7.41
5-YR RUN-OFF COEFFICIENT, C _s	TABLE 7-2	0.69	0.59	0.77	0.60
5-YR RAINFALL INTENSITY, I _s [IN/HR]	FIGURE 7-1	3.80	4.75	4.10	4.75
5-YR MAXIMUM RUN-OFF, Q _s [CFS]	Q=CIA	18.62	5.18	22.41	5.27
10-YR RUN-OFF COEFFICIENT, C ₁₀	TABLE 7-2	0.74	0.61	0.83	0.67
10-YR RAINFALL INTENSITY, I ₁₀ [IN/HR]	FIGURE 7-1	5.20	6.50	5.60	6.50
10-YR MAXIMUM RUN-OFF, Q ₁₀ [CFS]	Q=CIA	27.32	7.34	33.00	8.06
100-YR RUN-OFF COEFFICIENT, C ₁₀₀	TABLE 7-2	0.83	0.78	0.88	0.79
100-YR RAINFALL INTENSITY, I ₁₀₀ [IN/HR]	FIGURE 7-1	7.60	9.60	8.20	9.60
100-YR MAXIMUM RUN-OFF, Q ₁₀₀ [CFS]	Q=CIA	44.79	13.85	51.23	14.03

¹ City of Boulder Design and Construction Manual



Drexel, Barrell & Co.

Detention Storage Design

Modified FAA Method

Note: City of Boulder IDF Curve (Fig. 7-1) was used for Duration 5 min. - 60 min.

TOTAL POND VOLUME REQUIRED 10-Year Storage Volume

Project: Arapahoe Recycling
Project No: 20024

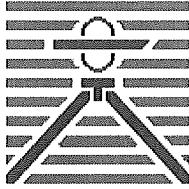
Date: 02/15/11
Calculated By: MAA

Tributary Area, [acres] $A = 7.10$
10-year Runoff Coefficient $C_{10} = 0.83$
Maximum Release Rate, [cfs] $Q_{H10} = 26.60$
Time of Concentration, [min] $T_c = 10.00$
1-hr Point Rainfall Depth, [in] $P_1 = 1.75$

T Rainfall Duration [min]	I Rainfall Intensity [in/hr]	V _i Inflow Volume EQN SO-5 [cf]	m Adjustment Factor EQN SO-6	Q _{AV} Average Outflow EQN SO-7 [cfs]	V _o Outflow Volume EQN SO-8 [cf]	V _s Storage Volume EQN SO-9 [cf]
0.00	8.16	0	1.00	26.60	0	0
5.00	7.40	13082	1.00	26.60	7980	5102
10.00	5.70	20154	1.00	26.60	15960	4194
15.00	4.50	23867	0.83	22.17	19950	3917
20.00	3.80	26872	0.75	19.95	23940	2932
25.00	3.33	29436	0.70	18.62	27930	1506
30.00	2.95	31292	0.67	17.73	31920	-628
35.00	2.64	32671	0.64	17.10	35910	-3239
40.00	2.40	33944	0.63	16.63	39900	-5956
45.00	2.18	34686	0.61	16.26	43890	-9204
50.00	2.02	35712	0.60	15.96	47880	-12168
55.00	1.89	36755	0.59	15.72	51870	-15115
60.00	1.80	38187	0.58	15.52	55860	-17673
65.00	1.68	38502	0.58	15.35	59850	-21348
70.00	1.59	39413	0.57	15.20	63840	-24427
75.00	1.52	40263	0.57	15.07	67830	-27567

10-Year Storage Volume Required = 5,102 cf

110% of 10-Year Storage Volume Required = 5,613 cf



Drexel, Barrell & Co.

Detention Storage Design

Modified FAA Method

Note: City of Boulder IDF Curve (Fig. 7-1) was used for Duration 5 min. - 60 min.

TOTAL POND VOLUME REQUIRED 100-Year Storage Volume

Project: Arapahoe Recycling
Project No: 20024

Date: 02/15/11
Calculated By: MAA

Tributary Area, [acres] $A = 7.10$
100-year Runoff Coefficient $C_{100} = 0.88$
Maximum Release Rate, [cfs] $Q_{H100} = 44.61$
Time of Concentration, [min] $T_c = 10.00$
1-hr Point Rainfall Depth, [in] $P_1 = 2.70$

T Rainfall Duration [min]	I Rainfall Intensity [in/hr]	V _i Inflow Volume EQN SO-5 [cf]	m Adjustment Factor EQN SO-6	Q _{AV} Average Outflow EQN SO-7 [cfs]	V _o Outflow Volume EQN SO-8 [cf]	V _s Storage Volume EQN SO-9 [cf]
0.00	12.60	0	1.00	44.61	0	0
5.00	11.00	20618	1.00	44.61	13383	7235
10.00	8.30	31115	1.00	44.61	26766	4349
15.00	6.68	37563	0.83	37.18	33458	4105
20.00	5.50	41237	0.75	33.46	40149	1088
25.00	4.70	44048	0.70	31.23	46841	-2792
30.00	4.18	47010	0.67	29.74	53532	-6522
35.00	3.77	49465	0.64	28.68	60224	-10758
40.00	3.42	51284	0.63	27.88	66915	-15631
45.00	3.14	52971	0.61	27.26	73607	-20636
50.00	2.90	54358	0.60	26.77	80298	-25940
55.00	2.70	55670	0.59	26.36	86990	-31320

100-Year Storage Volume Required = 7,235 cf

110% of 100-Year Storage Volume Required = 7,959 cf

Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Sheet 1 of 3

Designer: maa

Company: Drexel, Barrell & Co

Date: February 15, 2011

Project: 20024

Location: 3400 arapahoe

<p>1. Basin Storage Volume</p> <p>A) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)</p> <p>B) Contributing Watershed Area (Area)</p> <p>C) Water Quality Capture Volume (WQCV) ($WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$)</p> <p>D) Design Volume: $Vol = (WQCV / 12) * Area * 1.2$</p>	<p>$I_a = 83.05$ %</p> <p>$i = 0.83$</p> <p>Area = 7.100 acres</p> <p>WQCV = 0.35 watershed inches</p> <p>Vol = 0.2473 acre-feet</p>
<p>2. Outlet Works</p> <p>A) Outlet Type (Check One)</p> <p>B) Depth at Outlet Above Lowest Perforation (H)</p> <p>C) Recommended Maximum Outlet Area per Row, (A_o)</p> <p>D) Perforation Dimensions:</p> <p>i) Circular Perforation Diameter or</p> <p>ii) Width of 2" High Rectangular Perforations</p> <p>E) Number of Columns (nc, See Table 6a-1 For Maximum)</p> <p>F) Actual Design Outlet Area per Row (A_o)</p> <p>G) Number of Rows (nr)</p> <p>H) Total Outlet Area (A_{ot})</p>	<p>Orifice Plate</p> <p>Perforated Riser Pipe</p> <p>Other:</p> <p>H = _____ feet</p> <p>$A_o =$ _____ square inches</p> <p>D = _____ inches</p> <p>W = _____ inches</p> <p>nc = _____ number</p> <p>$A_o =$ _____ square inches</p> <p>nr = _____ number</p> <p>$A_{ot} =$ _____ square inches</p>
<p>3. Trash Rack</p> <p>A) Needed Open Area: $A_l = 0.5 * (\text{Figure 7 Value}) * A_{ot}$</p> <p>B) Type of Outlet Opening (Check One)</p> <p>C) For 2", or Smaller, Round Opening (Ref.: Figure 6a):</p> <p>i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1</p> <p>ii) Height of Trash Rack Screen (H_{TR})</p>	<p>$A_l =$ _____ square inches</p> <p><input checked="" type="checkbox"/> $\leq 2"$ Diameter Round</p> <p><input checked="" type="checkbox"/> 2" High Rectangular</p> <p>Other:</p> <p>$W_{conc} =$ _____ inches</p> <p>$H_{TR} =$ _____ inches</p>

Drexel, Barrell & Co.

Project 6400 ARAPAHOE Project No. 20024

Designed MM Date 2-15-11 Checked _____ Date _____ Sheet No. _____

DETENTION POND SUMMARY

HISTORIC RELEASE FROM SITE (EX A + EX B)

$$10\text{-YR} = 34.66 \text{ CFS}$$

$$100\text{-YR} = 58.64 \text{ CFS}$$

PROPOSED RELEASE FROM SITE (POND + PP B UNRETAINED)

$$\text{PP B UNRETAINED: } 10\text{-YR} = 8.06 \text{ CFS}$$

$$100\text{-YR} = 14.03 \text{ CFS}$$

$$\therefore \text{ALLOWABLE POND: } 10\text{-YR} = 26.6 \text{ CFS}$$

$$100\text{-YR} = 44.61 \text{ CFS}$$

$$10\text{-YR STORAGE} = 5,613 \text{ CF} \quad (110\%, \text{ FAA SPREADSHEET})$$

$$100\text{-YR STORAGE} = 7,959 \text{ CF} \quad (110\%, \text{ FAA SPREADSHEET})$$

$$\text{WQ VOLUME} = 0.2477 \text{ ACFT} = 10,772 \text{ CF} \quad (\text{UDFCD SPREADSHEET})$$

TOTAL VOLUME REQUIRED

$$\text{WQ} = 10,772 \text{ CF}$$

$$V_{10} = 16,385 \text{ CF}$$

$$(10\text{-YR STORAGE} + \text{WQ})$$

$$V_{100} = 13,345 \text{ CF}$$

$$(100\text{-YR STORAGE} + \frac{1}{2}\text{WQ})$$

TOTAL POND VOLUME PROVIDED

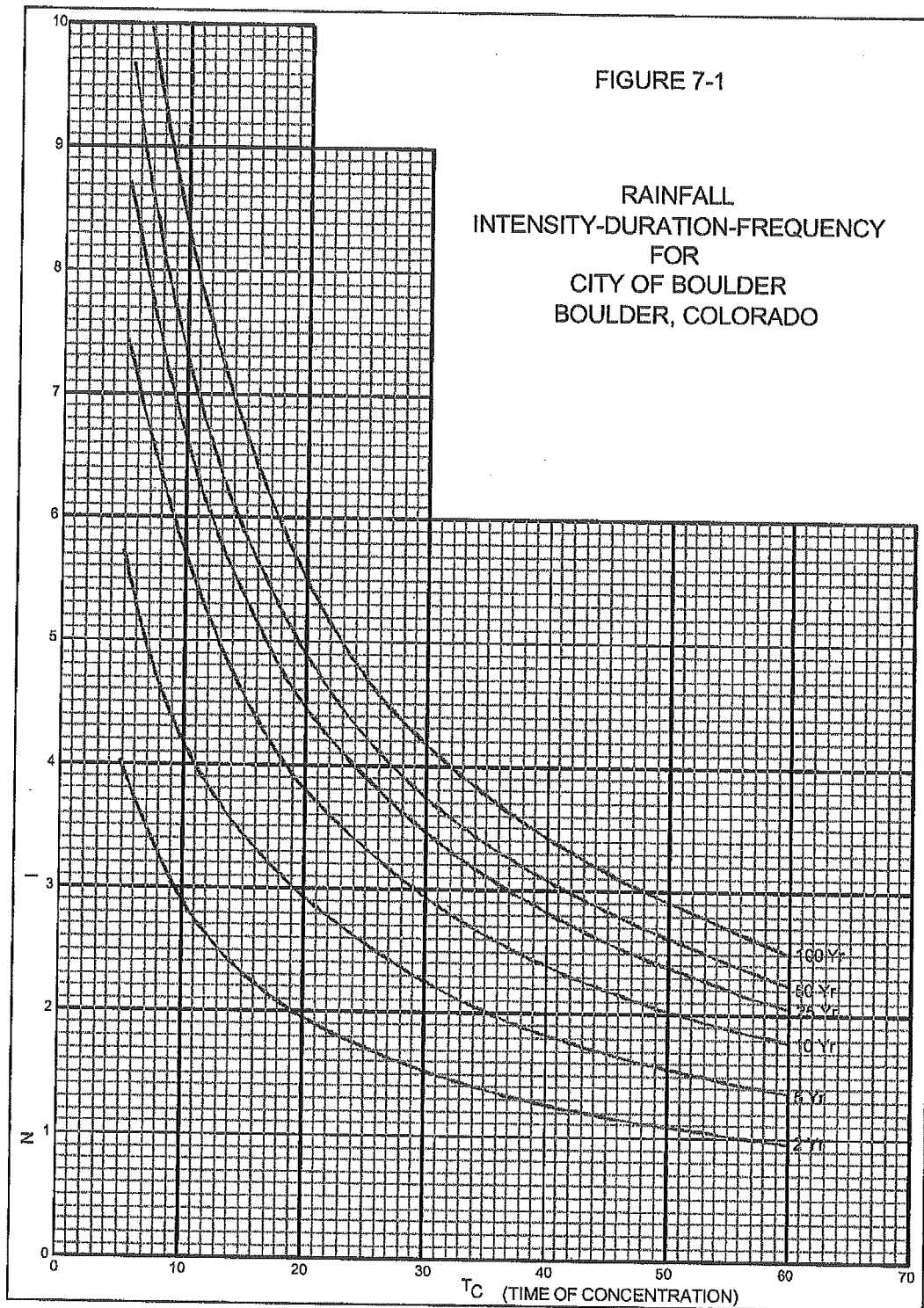
$$\text{WQ} = 11,124 \text{ CF} \quad @ \text{ WSEL} = 5247.4'$$

$$V_{10} = 16,902 \text{ CF} \quad @ \text{ WSEL} = 5248.1'$$

$$V_{100} = 13,500 \text{ CF} \quad @ \text{ WSEL} = 5247.7'$$

$$\text{TOTAL POND VOLUME} = 20,574 \text{ CF} \quad @ \text{ WSEL} = 5248.5'$$

APPENDIX D: STANDARD TABLES AND FIGURES



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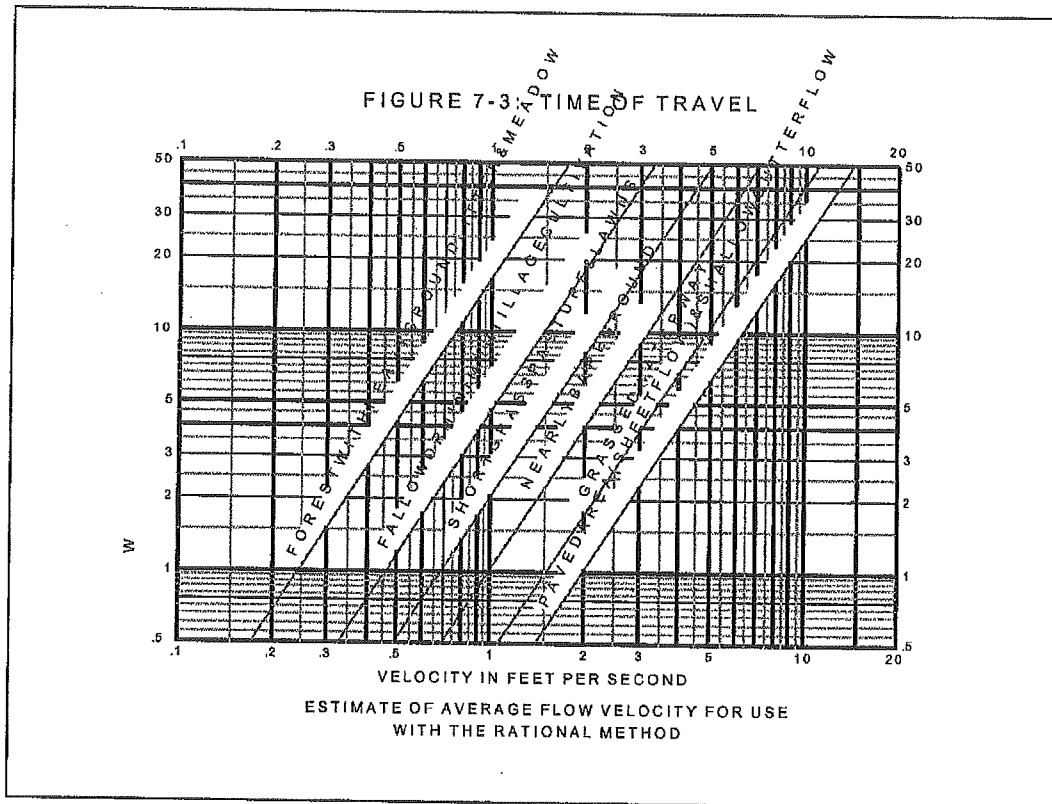


Table 7-2: Runoff Coefficients for the Rational Method

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	STORM FREQUENCY			
		2-Yr	5-Yr	10-Yr	100-Yr
<u>Business:</u>					
Commercial Areas	95	0.87	0.88	0.90	0.93
Neighborhood Areas	65	0.60	0.65	0.70	0.80
<u>Residential:</u>					
Single-Family	40	0.40	0.45	0.50	0.70
Multi-Unit (detached)	50	0.50	0.55	0.60	0.75
Multi-Unit (attached)	70	0.65	0.70	0.70	0.80
½ Acre Lot	30	0.30	0.40	0.45	0.65
Apartments	70	0.65	0.70	0.70	0.80
<u>Industrial:</u>					
Light Areas	80	0.75	0.80	0.80	0.85
Heavy Areas	90	0.80	0.80	0.85	0.90
<u>Parks, Cemeteries:</u>	7	0.15	0.25	0.35	0.60
<u>Playgrounds:</u>	13	0.20	0.30	0.40	0.70
<u>Schools:</u>	50	0.50	0.55	0.60	0.75
<u>Railroad Yard Areas:</u>	40	0.40	0.45	0.50	0.70
<u>Undeveloped Areas:</u>					
Historic Flow Analysis	2	0.10	0.20	0.30	0.60
Greenbelts, Agricultural	-	-	-	-	-
Offsite Flow Analysis (when offsite land use is not defined)	45	0.45	0.50	0.55	0.72
<u>Streets:</u>					
Paved	100	0.87	0.88	0.90	0.93
Gravel	7	0.15	0.25	0.35	0.65
<u>Drives and Walks:</u>	96	0.85	0.87	0.90	0.92
<u>Roofs:</u>	90	0.80	0.85	0.90	0.90
<u>Lawns:</u>					
Sandy Soil	0	0.00	0.10	0.20	0.50
Clayey Soil	0	0.10	0.20	0.30	0.60

NOTE: These rational formula coefficients do not apply for larger basins where the time-of-concentration exceeds 60 minutes.

(Source: Urban Drainage and Flood Control District)